US Army Corps
of Engineers
New England District

Drought Contingency Plan

SEPTEMBER 1997

Edward MacDowell Dam, Peterborough, New Hampshire

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The purpose of this study and report was to develop and set forth a possible drought contingency plan of operation for Edward MacDowell Dam that would be reponsive to public needs during drought periods and identify possible modifications to the project regulation within the current administration and legislative constraints. However, the state of New Hampshire has withdrawn support as sponsor for using Edward MacDowell Dam as a source of emergency supply; therefore, this plan is not implementable.

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SUMMARY

In the 1990's NED started updating drought contingency plans that were previously developed in the 1980's for some of our reservoirs. One of the requirements to updating the drought contingency plans, to make them fully implementable, is state sponsorship. If there is no state sponsorship then a nonfeasible plan will be published for that particular project.

In letter, dated February 14, 1997 (copy attached), the State of New Hampshire Department of Environmental Services (DES) withdrew its support as a sponsor for the drought contingency plan at Edward MacDowell Dam. The DES indicated for a variety of reasons, mainly the timing of the proposed drought storage, they currently are not interested in sponsoring emergency storage at the project. Therefore, the New Hampshire DES is not interested in entering into a contract with the Corps.

Since there is no state sponsorship for drought storage at Edward MacDowell Dam, the drought contingency plan developed in 1984 is presented herein for informational purposes only. If, at some future date, the state were to indicate an interest, drought contingency storage will be re-evaluated and this report updated as necessary to respond to the state request.

DROUGHT CONTINGENCY STORAGE FOR EMERGENCY WATER SUPPLY PURPOSES AT EDWARD MacDOWELL DAM IS NOT IMPLEMENTABLE

NHDES

State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES
64 No. Main Street, P.O. Box 2008, Concord, NH 03302-2008
(603) 271-3406 FAX (603) 271-7894

February 14, 1997

Richard D. Reardon
Director of Engineering
Department of the Army
New England Div., Corps of Engineers
424 Trapelo Rd
Waltham MA 02254-9149

Dear Mr. Readon:

Your letter of February 4, 1997 requests information relative to the State of New Hampshire's participation in a Drought Contingency Plan and Memorandum of Agreement for the above referenced projects. By way of background, it is my understanding from previous studies and discussion with your staff that the contingency plan could only be implemented after declaration of a drought emergency by the State. At that time, the Corps would reduce discharge from the reservoirs to store the stipulated amount of water for later release as requested.

This approach presents a problem to us because once a drought emergency is declared we are already experiencing extremely depleted streamflows. Further reduction in streamflows to store water would increase the adverse effects already being experienced. Based upon this understanding, the state is not interested in participating in an agreement at this time.

We have advocated in the past for a permanent reallocation of a small portion of the flood control storage for streamflow maintenance and drought mitigation. Should you be able to raise the normal pool the two to three feet proposed in the drought plan on a permanent basis, this water would be available to mitigate drought impact. This is a far more fundamental issue which must be addressed relative to the mission of the projects. More active management of some of the available storage for other purposes on a seasonal basis is an item for future discussion.

Thank you for inquiring as to our interest. Should you have any questions, please contact me at your convenience.

Sincerely,

Kenneth J. Stern, PE
Chief Water Resources Engineer

cc: Robert W. Varney, Commissioner
Edward J. Schmidt, Director
KJS\ss\h:\kjs\reardon.ltr

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

REPLY TO
ATTENTION OF

February 4, 1997

Engineering - Water Control

Mr. Kenneth Stern, Chief Engineer
New Hampshire Department of Environmental Services
Water Division
P.O. Box 2008
Concord, New Hampshire 03302-2008

Dear Mr. Stern:

The New England Division, Corps of Engineers, is currently updating previously developed plans for drought contingency storage at some of our reservoirs in New Hampshire. We have identified these projects as having merit in providing a source of water supply during drought emergency conditions. We are writing to you with respect to the State of New Hampshire's interest in emergency storage at these projects. Listed below are names and locations of each candidate reservoir in your State. Attachments 1 through 4 present fact sheets with pertinent information for each project, and attachments 5 and 6 show locations.

Name	Location
Edward MacDowell Dam*	Peterborough
Surry Mountain Lake	Surry
Everett Lake	Weare

* 1992 investigations indicated no interest from the town of Peterborough or other communities in the area

These are the remaining three Drought Contingency Plans (DCP) to be updated for your State. As you know, an updated plan for Otter Brook Lake was completed in 1992 and has been excluded from the above list. This implementable plan lists your agency as the lead agency to act as sponsor for the plan.

The DCP presents a basic planning aid assessment of Corps projects as a potential emergency short-term water supply source during a State-declared drought emergency, with each DCP identifying the following:

a. Hydrologic assessment of drought storage potential.

b. Standard operating procedure for drought storage and releases.

c. State participation in the plan.

d. Draft Memorandum of Agreement (contract) identifying how water will be received and distributed as well as cost.

In an effort to update the DCPs for these projects, we are requesting your agency forward a letter to this office expressing your interest (or lack of interest) in participating in the program for each of the remaining candidate reservoirs in your State. You are; therefore, encouraged to review the attached information on the proposed plans and determine your interest in the plans. If there is interest, your letter should identify the appropriate State-sponsored agency acting as signatory to the contract, potential water supply user, and method of transporting water (i.e., reservoir releases, trucking, etc.) for each project.

It should be noted that your 1992 investigations indicated no interest on the part of Peterborough, or other communities in the area, in the use of emergency storage from Edward MacDowell Dam for potable water supply. The attached information sheets on the proposed Edward MacDowell Dam emergency storage plan (attachment 1) and historic low flow data (attachment 2) are provided so you can decide whether there is State interest in the use of emergency storage.

In conclusion, your letter should be a response with respect to the State of New Hampshire's interest in Edward MacDowell Dam, Surry Mountain and Everett Lakes for emergency storage. If you have any questions regarding this request, please contact Mr. Steven Simmer at 617-647-8524.

Sincerely,

Richard D. Reardon
Director of Engineering

Attachments

CF:
Mr. Simmer - 115N
Reading Files
Engr Dir Files - 112S

MERRIMACK RIVER BASIN
CONTOOCOOK RIVER WATERSHED

DROUGHT CONTINGENCY STORAGE PLAN
EDWARD MAC DOWELL DAM
PETERBOROUGH, NEW HAMPSHIRE

SEPTEMBER 1984

NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

SYLLABUS

A drought contingency storage plan was studied for Edward MacDowell Dam in an effort to be responsive to public needs during drought situations. It was determined that water could be temporarily stored to an elevation of 913 feet NGVD, 2 feet above the permanent pool, providing up to approximately 425 acre-feet (138 million gallons) of reservoir storage for drought emergency purposes.

An evaluation of the effects of this plan has revealed some adverse impacts on the aquatic ecosystem and wildlife habitat. The water at Edward MacDowell Dam is of basically good quality but has high levels of color and metals which have to be removed before it is adequate for public water supply.

DROUGHT CONTINGENCY PLAN
EDWARD MAC DOWELL DAM

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DROUGHT CONTINGENCY STORAGE PLAN
EDWARD MAC DOWELL DAM

1. PURPOSE AND SCOPE

The purpose of this study and report was to develop and set forth a drought contingency storage plan of operation for Edward MacDowell Dam that would be responsive to public needs during drought periods and to identify possible constraints. This evaluation was based on preliminary studies using readily available information. This drought contingency plan includes a description of existing water supply systems, the possibility of reallocation of reservoir storage within specified limits, evaluation of reservoir storage within specified limits, evaluation of water quality, discussion of impacts on other project purposes, effects on the environment, and summary and conclusions.

2. AUTHORIZATION

The authority for the preparation of drought contingency plans is contained in ER 1110-12-1941 which provides that water control managers will continually review and, when appropriate, adjust water control plans in response to changing public needs. Drought contingency plans will be developed on a regional, basin wide and project basis as an integral part of water control management activities.

3. PROJECT AUTHORIZATION CONDITIONS

Edward MacDowell Dam was authorized as a flood control project by the Flood Control Act of 22 June 1936 (Public Law 738, 74th Congress), as modified by the Flood Control Act of 28 June 1938 (Public Law 761, 75th Congress).

4. PROJECT DESCRIPTION

Edward MacDowell Dam, completed in 1950, is located on Nubanusit Brook, a tributary of the Contoocook River, about one-half mile upstream of the village of West Peterborough, New Hampshire. A map of the Merrimack River Basin is shown on plate 1.

The project contains storage for flood control and conservation. The conservation pool at elevation 911 contains 150 acre-feet equivalent to 0.06 inch of runoff. This pool is maintained at a depth of approximately 7 feet creating a 165 acre pool. The flood control storage amounts to 12,650 acre-feet (4.1 billion gallons) when filled to spillway crest, which is equivalent to 5.4 inches of runoff from the 44-square mile drainage area. A capacity table is shown on plate 2 and a summary of pertinent data at Edward MacDowell Lake is contained on plate 3.

Components of the project consist of a dam of compacted earth and rock slope protection, outlet works and concrete spillway. The outlet works consist of a 7′ x 7′ concrete tunnel with an invert at elevation 904 feet NGVD. Flow through the outlet is controlled by three 3′ x 7′ electrically operated slide gates.

It should be noted that a permit application has recently been filed with the Federal Energy Regulatory Commission by a private firm for the purpose of developing hydropower at Verney Mills dam located about 1,000 feet downstream of MacDowell Dam. Should this license be granted, the storage of water for drought purposes would be seriously impacted.

5. PRESENT OPERATING REGULATIONS

a. Normal Periods. The gates will be operated at the project manager's discretion to maintain a conservation pool between elevations 910 and 911 feet. In order to prevent their freezing, the gates will be operated to keep a winter pool between elevations 911 and 912 feet.

b. Flood Periods. The MacDowell project is operated in concert with other projects in the basin to reduce downstream flooding along Nubanusit Brook and the Contoocook River and further downstream in the Merrimack River. Operations for floods may be considered in three phases: phase I - appraisal of storm and river conditions during development of a flood, phase II - flow regulation and storage of flood runoff at the reservoir, and phase III - emptying the reservoir during recession of the flood. The regulation procedures are detailed in the Master Water Control Manual for the Merrimack River Basin.

c. Regulating Constraints

(1) Minimum Releases. A minimum release of about 10 cfs (6.5 mgd) is maintained during periods of flood regulation in order to sustain downstream fish life.

(2) Maximum Releases. The maximum nondamaging discharge capacity of the channel immediately downstream of Edward MacDowell Lake is about 650 cfs. Releases at or near this rate can be expected whenever reservoir inflows exceed this value, and meteorologic and hydrologic conditions permit.

6. MONITORING OF HYDROLOGIC CONDITIONS

The Reservoir Control Center directs the reservoir regulation activities at 28 New England Division flood control dams, and

continually monitors rainfall, snowcover and runoff conditions throughout the region. When any of these hydrologic parameters have been well below normal for several months and it appears that possible drought conditions might develop, the Corps Emergency Operations Center (EOC) will be so informed. The EOC will then initiate discussions with the respective Federal and Stage agencies and other in-house Corps elements to review possible drought concerns and future Corps actions.

a. General. The area of concern is the central portion of New Hampshire including portions of Cheshire and Hillsborough counties. Table 1 contains information about public water suppliers in the area based on information provided by the New Hampshire Water Supply and Pollution Control Commission. Of the 17 communities in the study area, 12 are served by public systems. No data is available for those communities dependent on private individual supplies.

b. Water Supply Systems. The primary objective of this analysis was to accumulate available data regarding water supply systems in the vicinity of MacDowell Dam that could benefit from storage at the project, and to present the data in a manner portraying existing water supply conditions. Projections of future demands were not developed because this study addresses only modifications in the operational procedure at Edward MacDowell Lake in order to provide storage for water supply purposes when drought conditions exist, and not to meet normal water supply demands at some future date.

c. Central New Hampshire Water Suppliers. As noted in table 1, the data given for each water supplier includes: community served, estimated population served by the system, source of supply (ground or surface water), average day and maximum day demands for 1981, estimated safe yield of the source, and any further information available on the source of supply. An analysis of the adequacy of existing sources during drought conditions has not been performed. The information has been accumulated to present a summary of the existing water supply conditions for the central New Hampshire area.

d. Population Projections. Population projections for communities in central New Hampshire are given in table 2 to show population trends for each community potentially affected by a prolonged dry period. The projections were provided by the New Hampshire Office of State Planning based on criteria derived by the Corps of Engineers for the Southeastern New Hampshire Water Resources Study.

TABLE 1
MAJOR WATER SUPPLIERS - CENTRAL NEW HAMPSHIRE

Company or Agency	Town Served	Est. Population Served 1981	Source of Supply SW/GW	1981 Demand Avg. Day (MGD)	1981 Demand Max. Day (MGD)	Supply Source	Safe Yield (MGD)
Antrim Precinct	Antrim	1,150	SW/GW	0.075	0.150	Campbell Pond	0.15
						GP #1	0.90
Bennington Water	Bennington	530	GW	0.100	0.130	Bel Geddes Red. AB	
						GP #1	1.70
Concord Water	Concord	(7198 Connections)	SW/GW	4.043	6.150	Long Pond	2.60
						Contoocook R (Aux)	10.60
						GP #1 Tr. Pond	1.00
						GP #3	1.00
						GP #5	1.00
						GP #7	1.00
	Deering	(9 Connections)				Hillsborough Water Works	
	Dublin		No Public Water Supply				
	Greenfield		No Public Water Supply				
Hancock Water Works	Hancock	450	SW	0.048	0.100	Juggernaut Pond	0.16
						Dan's Br. (Aux)	—
	Harrisville		No Public Water Supply				
Cogswell Springs Water Works	Henniker		GW	0.350	0.450	GP #1	—
						GP #2	—
						GP #3	—
Hillsboro Water Works	Hillsboro	2000	SW	0.300	0.450	Loon Lake	1.20
Hillsboro Water Co., Inc. (Emerald Lake Shores)		(275 Connections)	GW			BR #1	—
						BR #2	—
						BR #3	—
						BR #4	—
Contoocook Fire District	Hopkinton	1,500	SW	0.225	0.320	Bear Pond	0.48
Jaffery Water Works	Jaffery	7,500	SW/GW	0.700	1.100	Bullet Pond	0.13
						Poole Reservoir	0.12
						GP E. Main St.	0.20
						GP Contoocook L.	0.50
Peterboro Water Dept.	Peterboro	3,386	SW/GW	0.600	1.100	GP North Well	0.86
						GP South Well	0.50
						Cuningham Pd. (Aux)	0.10
	Sharon		No Public Water Supply				
	Temple		No Public Water Supply				

TABLE 2
POPULATION PROJECTIONS - CENTRAL NEW HAMPSHIRE

TOWN	Actual 1980	1985	1990	1995	2000	Percent-Change 1980-200
Antrim	2,203	2,411	2,482	2,564	2,680	21.7
Bennington	891	1,026	1,107	1,194	1,247	40.0
Concord	30,360	31,502	32,107	32,774	33,639	10.8
Deering	1,046	1,204	1,299	1,400	1,462	39.8
Dublin	1,297	1,502	1,721	1,966	2,163	66.8
Greenfield	958	1,014	1,015	1,022	1,070	11.7
Hancock	1,189	1,232	1,254	1,277	1,291	8.6
Harrisville	855	991	1,143	1,312	1,444	68.9
Henniker	3,236	3,612	3,915	4,251	4,558	40.9
Hillsboro	3,431	3,747	3,924	4,110	4,222	23.1
Hopkinton	3,841	4,314	4,713	5,149	5,471	42.4
Jaffrey	4,361	5,055	5,807	6,490	7,020	61.0
Peterboro	4,897	5,380	5,650	5,935	6,109	24.7
Sharon	186	214	231	249	260	39.8
Temple	686	790	850	916	957	39.5
TOTAL	59,437	63,994	67,218	70,609	73,593	23.8

8. POTENTIAL FOR WATER SUPPLY REALLOCATION

a. General. There are several authorities that provide for the use of reservoir storage for water supply at Corps of Engineers projects. They vary from the provision of water supply storage as a major purpose in new projects to the discretionary authority to provide emergency supplies to local communities in need. In addition, guidance contained in ER 1110-2-1941 directs field offices to determine the short-term water supply capability of existing Corps reservoirs that would be functional under existing authorities. Congressional authorization is not required to add municipal and industrial water supply if the related revisions in regulation would not significantly affect operation of the project for the originally authorized purposes.

b. Drought Contingency Storage. It has been determined that a portion of the existing storage at Edward MacDowell Lake could be utilized for emergency drought storage without having an adverse impact on the project's flood control function. Storage could be made available to a pool elevation of about 913 feet NGVD (9-foot stage). This represents a volume of about 425 acre-feet, equivalent to 138 million gallons or about 3 percent of the total reservoir storage. This volume is comprised of 150-acre feet of permanent storage (elevation 911), and 275-acre-feet of flood control storage (elevation 913). The 275 acre-feet represents an infringement of about 0.10 inches of runoff on the flood control storage.

Based on an all-season low flow duration analysis using 46 years of flow records for the gaging station on Nubanusit Brook near Peterborough, New Hampshire, it was determined that during a 10-year frequency drought period, the volume of runoff could: a) fill the reservoir from elevation 911 to 913 feet in a 17-day summer period provided no releases were made from the dam, or b) fill the reservoir to elevation 913 in a 32-day period if a continuous release of about 4.4 cfs or 2.8 mgd (0.10 cfs/sq. mi. cfs,) were maintained. Drought contingency storage versus flow duration at Edward MacDowell Lake is graphically shown on plate 4.

Edward MacDowell Lake could be filled to elevation 913 feet in about one week in May while continuously releasing about 10 cfs or 6.5 mgd. The stored water could be drawn directly from the reservoir or released downstream for municipal supply with proper treatment.

c. Effects of Regulated Flows. The curtailment of flows from Edward MacDowell Lake during the drought emergency could adversely impact on the flowage rights of downstream riparian users. At this time, however, it so not possible to review all of the various drought emergency situations that could occur, nor is it within the scope of this report to identify all those with water rights. It is important to note that when a specific drought emergency does occur, the legal implications would have to be weighed.

9. WATER QUALITY EVALUATION

a. Water Quality Classification. The entire length of Nubanusit Brook and its tributaries in New Hampshire is rated class B by the New Hampshire Water Supply and Pollution Control Commission. Class B waters have high aesthetic value and are acceptable for swimming and other recreation, fish habitat and, after adequate treatment, for use as water supplies.

Technical requirements for class B waters include no objectionable physical characteristics, a minimum dissolved oxygen concentration of 75 percent saturation or 6 mg/l, pH in the range of 6.5 to 8.0 standard units or as naturally occurs, no more than 240 coliform bacteria per 100 milliliters, and a maximum turbidity level of 10 JTU.

c. Existing Water Quality. There are no significant point-source discharges upstream and the waters of Edward MacDowell Lake are of good quality, generally meeting the requirements of their New Hampshire class B designation. DO levels in Nubanusit Brook and Edward MacDowell Lake are consistently high. Other water quality measurements indicating good conditions are low levels of coliform bacteria and turbidity.

While Edward MacDowell's water quality is good, certain measurements indicate some treatment will be required for water supply usage. Natural conditions (swamps, marshes) along some tributaries to Nubanusit Brook contribute to low pH levels and high iron, mercury, and color concentrations.

Low pH levels, also affected by acid rain runoff, frequently violate state criteria. In a public water supply low pH levels are not a health problem but may cause corrosion problems.

High metal and color concentrations do not violate state standards but are not desirable in a public water supply. High iron levels at Edward MacDowell Lake are rare. Iron is not a health hazard in water, but high levels of iron can cause taste and laundry-staining problems. Findings of detectable concentrations of mercury at this project are very rare, but a few slightly elevated readings have been recorded. Color concentrations are moderate to high. While not a health hazard, highly colored water is unappealing to water consumers. High color, iron, and mercury levels can be reduced by standard treatment processes.

MacDowell Lake is a borderline mesotrophic-oligotrophic impoundment with a hydraulic residence time of 1 to 3 days under normal summer flow conditions. Under minimum flow conditions, the

hydraulic residence time increases to 2-3 weeks. Low nutrient levels and short hydraulic detention time indicate this lake should be well protected from algal blooms. Temperatures in the brook are frequently higher than the optimum (68°F) to support a good cold water fishery but rarely exceed the 85°F maximum to support warm water fishing.

c. Water Quality Requirements for Drought Storage. There are two requirements to be met. The waters must meet state standards for surface waters and must be of a quality appropriate for the water supply user. A water which meets class B standards in New Hampshire is usable for public water supply with standard treatment processes. The water quality required for industrial water supply depends on the industrial process involved. The water at Edward MacDowell Lake would always be of a quality suitable for fire-fighting or irrigation.

d. Effects of Drought Storage. Increasing the size of the pool at MacDowell Lake for drought storage will not affect existing water quality in the lake significantly. With the proposed depth increase of 2 feet, an additional 37 acres of land would be flooded. The decay or organic material on this land may use small increases in levels of color and soluble nutrients. Present hydraulic residence time during normal summer flow conditions would increase from 1 to 3 days to 5 to 7 days and under minimum flows would increase from 2 to 3 weeks to 6 to 10 weeks. The trophic status of the lake is not likely to change and the water quality for recreation and fishing will not be affected.

Raising the pool 2 feet would also cause slight increases in turbidity and sedimentation. The death of the vegetation in the newly inundated areas would loosen the soil and cause increased erosion in these areas when the pool came down. Most of the eroded soil would settle in the lake, but some would be discharged downstream. This increased erosion and sedimentation will not affect the suitability of the water for water supply or recreation, but will diminish the aesthetics of the area.

e. Water Quality Conclusions. The water at Edward MacDowell Lake is of basically good quality but has high levels of color and metals which will have to be removed before it is usable for public water supply. Undesirable color and metals can be removed by standard treatment processes. No treatment would be required for the water to be acceptable for fire-fighting, irrigation, or some industrial processes. Increasing the pool elevation by 2 to 4 feet to provide extra storage would elevate levels of turbidity, color, and erosion and sedimentation somewhat but would not significantly affect the suitability of the water for water supply or recreation.

10. DISCUSSION OF IMPACTS

a. General. Any action resulting in a temporary change of a reservoir's storage volume might have impacts on other project purposes which must be evaluated before a storage reallocation plan can be implemented. An evaluation has been made of the impacts resulting from drought contingency storage on the flood control purpose of this project. Effects on recreation, sedimentation and the aquatic and terrestrial environments as well as the historic and archaeological resources are also discussed in the following paragraphs. Because of the minimal level of effort afforded this study, certain environmental concerns may require further consideration prior to project implementation. These are identified in the appropriate environmental sections, with estimates of the amount of time needed for such further assessments.

b. Flood Control. A review of the regulation procedures at Edward MacDowell Lake was undertaken to determine the volume of water that could be made available for drought contingency purposes. The water would be stored by temporarily utilizing existing flood control storage. It is recognized that major floods occur in every season of the year, thus any use of flood control storage would be continually monitored to insure there would be no adverse impacts on downstream flood protection.

At MacDowell the maximum pool elevation for drought contingency storage has been estimated to be elevation 913 feet, representing an infringement on the flood control storage of about 0.10 inches of runoff from the upstream 44 square mile drainage area.

Based on a 10-year event, the anticipated rate of pool level rise would exceed 0.06 feet per day over a 32-day period beginning in June. This condition assumes a flow about 4.4 cfs (2.8 mgd) would be released downstream for the duration of the drought. Storage would probably take place during the months of June, July and August and would be drawn as needed in the following months. The storage may be held for a period of one month or longer at the 913-foot elevation before withdrawal.

c. Recreation. The proposed storage should have little effect upon recreation.

d. Project Operation. The proposed drought contingency storage should have little effect upon the Operations and Maintenance of the project. The east access road to the interior project area will be at or slightly below the proposed 9 foot stage.

e. Effects on the Aquatic Ecosystem. The aquatic environment of the project area is located along the Nubanusit Brook and the

Brush and Stanley Brooks in the Merrimack River basin, including the impoundment behind the dam, Halfmoon Pond, Donmore Pond, and Beaver Pond. The waters of Nubanusit Brook and its tributaries upstream from Edward MacDowell Lake are rated class B: of high aesthetic value, acceptable for swimming and other recreation, fish habitat, and after adequate treatment for use as water supplies.

The feeder streams do not support any salmonid populations due to the poor riffle-pool configuration. Virtually the same species as in the impoundment are found in the feeder streams. The fishery in the impoundment is a moderate to dying warm water fishery constrained by the shallow water depth. Standing crops are low. The following are among the species represented: yellow perch,, white sucker, pumpkinseed, bluegill, carp, brown bullhead, golden shiner, small-mouth bass, crayfish, and chain pickerel. Fishing pressure at the impoundment and in the streams is moderate. An increase in depth of the impoundment may benefit warm water fisheries by stabilizing spawning and feeding areas due to a decrease in the impoundment's water fluctuations, but this would warrant a few days further investigation. Periodically in the past, trout have been stocked downstream by the state.

Aquatic plants are common in the shallows, in the margins, and on the upper part of the impoundment. These species include pondweed, duckweed, pickerelweed, and waterlilies. The 40 acres of land that would be submerged by the drought contingency pool is comprised almost entirely of freshwater marsh. Some impact on these marshes and their inhabitants would be expected. A few days investigation prior to implementation would be necessary.

There are no known endangered aquatic species present in the project area.

f. Effects on the Terrestrial Environment. The terrestrial environment around the existing pool is comprised primarily of an oak-pine forest. The shoreline is of a shallow slope except in the southwestern portion adjacent to the dam. Common species found in the area surrounding Edward MacDowell Lake include white pine, red oak, white ash, black birch, red maple, hemlock, sugar maple, aspen, and beech.

The terrestrial environment would not be significantly impacted by development of a drought contingency pool since very little terrestrial habitat would be inundated. Plate 5 shows a map of the reservoir area.

g. Effects on Wildlife. Most of the attention given by the New Hampshire Fish and Game Department to the MacDowell Lake area has been focused on waterfowl habitat maintenance. Periodic inundations may have an impact on the waterfowl habitat.

Several days further investigation would be required to better define this. Most waterfowl nest in April through June and would probably be most adversely affected by rising water levels during that time period. Nesting losses of broods and food supplies would be dependent on when water levels rose and their duration. Wood ducks are the most prevalent species, with some blacks and mallards. Pheasant were previously stocked in this area, but this practice was discontinued. The open areas needed for suitable pheasant habitats were not available. Occasionally great blue heron, osprey, and red-shouldered hawk can be sighted in the area. Other wildlife species prevalent in the project area include beaver, deer, red fox, snow-shoe hare, muskrat, porcupine, cottontail rabbit, raccoon, skunk, greay squirrel, woodchuck, river otters, and fishers. Impacts from inundating waters could adversely affect those species which utilize the wetland habitat. A few days further investigation would be needed to clarify these impacts.

h. Historical and Archaeological Resources. Examination of historic period maps reveals one recorded historic period site near or below 913 NGVD. No prehistoric resources are recorded within the project. As the project has never been subjected to an archaeological survey, unrecorded prehistoric or historic resources may exist within the area affected by this drought contingency plan. Therefore, should this plan be implemented, an archaeological reconnaissance survey of the impact area involving several weeks duration will be necessary to determine what, if any, resources are affected and the severity of any impacts upon them.

11. SUMMARY AND CONCLUSIONS

It has been determined that a portion of the existing storage at Edward MacDowell Lake could be utilized for emergency drought purposes without having an adverse impact on the project's flood control functions. The water could be temporarily stored to an elevation of 913 feet. At this level, 2 feet above the permanent pool, it would be possible for the project to provide up to approximately 425 acre-feet (138 million gallons) of reservoir storage for drought emergency purposes. An evaluation of the effects of this plan has revealed some adverse impacts on the aquatic ecosystem and wildlife habitat.

The water at Edward MacDowell is of basically good quality but has high levels of color and metals which will have to be removed before it is adequate for public water supply. Undesirable color and metals can be removed by standard treatment processes. No treatment would be required for the water to be acceptable for fire-fighting, irrigation, or some industrial processes.

LINCOLN LOCAL PROTECTION

FRANKLIN FALLS DAM

BLACKWATER DAM

HOPKINTON-EVERETT LAKES

EDWARD MacDOWELL DAM

NASHUA LOCAL PROTECTION

HAVERHILL LOCAL PROTECTION

FITCHBURG LOCAL PROTECTION

LOWELL LOCAL PROTECTION

SAXONVILLE LOCAL PROTECTION

LOCATION MAP

SCALE IN MILES

0 10 20 30 60

LEGEND

△ STREAM GAGING STATION

♦ CORPS SNOW SURVEY COURSE

SCALE IN MILES

0 4 8 12 16

WATER RESOURCES DEVELOPMENT PROJECT

MERRIMACK RIVER BASIN

BASIN MAP

NEW ENGLAND DIVISION, WALTHAM, MASS.

PLATE 1

MACDOWELL RESERVOIR
AREA AND CAPACITY TABLE

Drainage Area = 44 Sq. Mi.

Pool Elev. (ft msl)	Area (acres)	Total Capacity (acre-ft)	Total Capacity (inches)
904	0	0	0.0
911	165	150	0.06
912	185	275	0.12
913	202	425	0.18
914	220	625	0.27
915	235	825	0.35
916	248	1,050	0.45
917	259	1,275	0.54
918	270	1,525	0.65
919	279	1,800	0.77
920	288	2,100	0.90
921	296	2,400	1.02
922	304	2,700	1.15
923	311	3,000	1.28
924	318	3,300	1.41
925	325	3,625	1.55
926	331	3,950	1.68
927	337	4,275	1.82
928	343	4,625	1.97
929	349	4,975	2.12
930	353	5,325	2.27
931	358	5,675	2.42
932	363	6,025	2.57
933	368	6,375	2.72
934	372	6,750	2.88
935	375	7,125	3.04
936	379	7,525	3.21
937	382	7,925	3.38
938	387	8,360	3.56
939	393	8,775	3.74
940	406	9,225	3.93
941	445	9,675	4.12
942	550	10,225	4.36
943	635	10,775	4.59
944	710	11,375	4.85
945	780	12,025	5.13
946(1)	840	12,800	5.45
949(2)	1,023	15,400	6.56

961 - Maximum Design Surcharge

967 - Top of Dam

(1) Spillway Crest

(2) Fee-taking elev., except Half-Moon Pond area, which is easement to 949.

PLATE 2

PERTINENT DATA

MAC DOWELL DAM AND RESERVOIR

LOCATION	Nubanusit Brook, Peterborough, New Hampshire
DRAINAGE AREA	44 square miles
STORAGE USES	Flood control and conservation

RESERVOIR STORAGE

	Stage (ft, msl)	Area (acres)	Acre-Feet	Inches on Drainage Area
Inlet Elevatio	904.0	0	0	0
Conservation Pool	911±	165	150	less than 0.1
Spillway Crest	946	840	12,650 (net)	5.4 (net)
Maximum Surcharge (Des. Criteria)	960.8	1,875	18,800 (net)	8.0 (net)
Top of Dam	967	-	-	-

EMBANKMENT FEATURES

Type	Rolled earth fill with rock slope protection
Length (feet)	11,000
Top Width (feet)	25
Top Elevation (ft, msl)	967
Height (feet)	67
Volume (cubic yards)	210,000
Dikes	None

SPILLWAY

Location	3.2 miles northeast of dam at Halfmoon Pond
Type	Chute spillway, ogee weir
Crest Length (feet)	100
Crest Elevation (feet, msl)	946
Max. Design Surcharge Elev. (ft, msl)	961 (at the dam)
Maximum Discharge Capacity (cfs)	16,600

OUTLET WORKS

Type	7' x 7' conduit
Tunnel Length (feet)	275
Service Gate Type	3 slide gates, each 3' wide x 7' high, electrically operated
Emergency-Type Gates	None
Downstream Channel Capacity	650 cfs (approximate)
Maximum Discharge Capacity Spillway Crest Elevation	1,600 cfs
Stilling Basin	25' wide x 40' long

LAND ACQUISITION

Fee Elevation (ft, msl)	949*
Fee (acres)	1,194
Easement (acres)	258**
Clearing Elevation (ft, msl)	913 (approximate)
Verney Mills Dam	Dam and surrounding 4 acres (fee)

* Except lands bordering Halfmoon Pond, which is flowage easement to 949.

** Includes lands bordering Davis and Ferguson Brooks between Middle Hancock Road and Route 202 that would be inundated by a spillway discharge of 3,000 cfs.

MAXIMUM POOL OF RECORD

Date	January 1956
Elevation (ft, msl)	936
Percent Full	58

SPILLWAY DESIGN FLOOD

	Original Design	1973 Criteria
Peak Inflow (cfs)	36,300	30,100
Spillway Discharge (cfs)	17,800	14,200

UNIT RUNOFF

One Inch Runoff (acre-feet)	2,350

OPERATING TIME

Open/Close Conduit Gates	About 20 minutes
PROJECT COST (Through FY 74)	$2,014,000
DATE OF COMPLETION	April 1950
MAINTAINED BY	New England Division, Corps of Engineers

PLATE 3

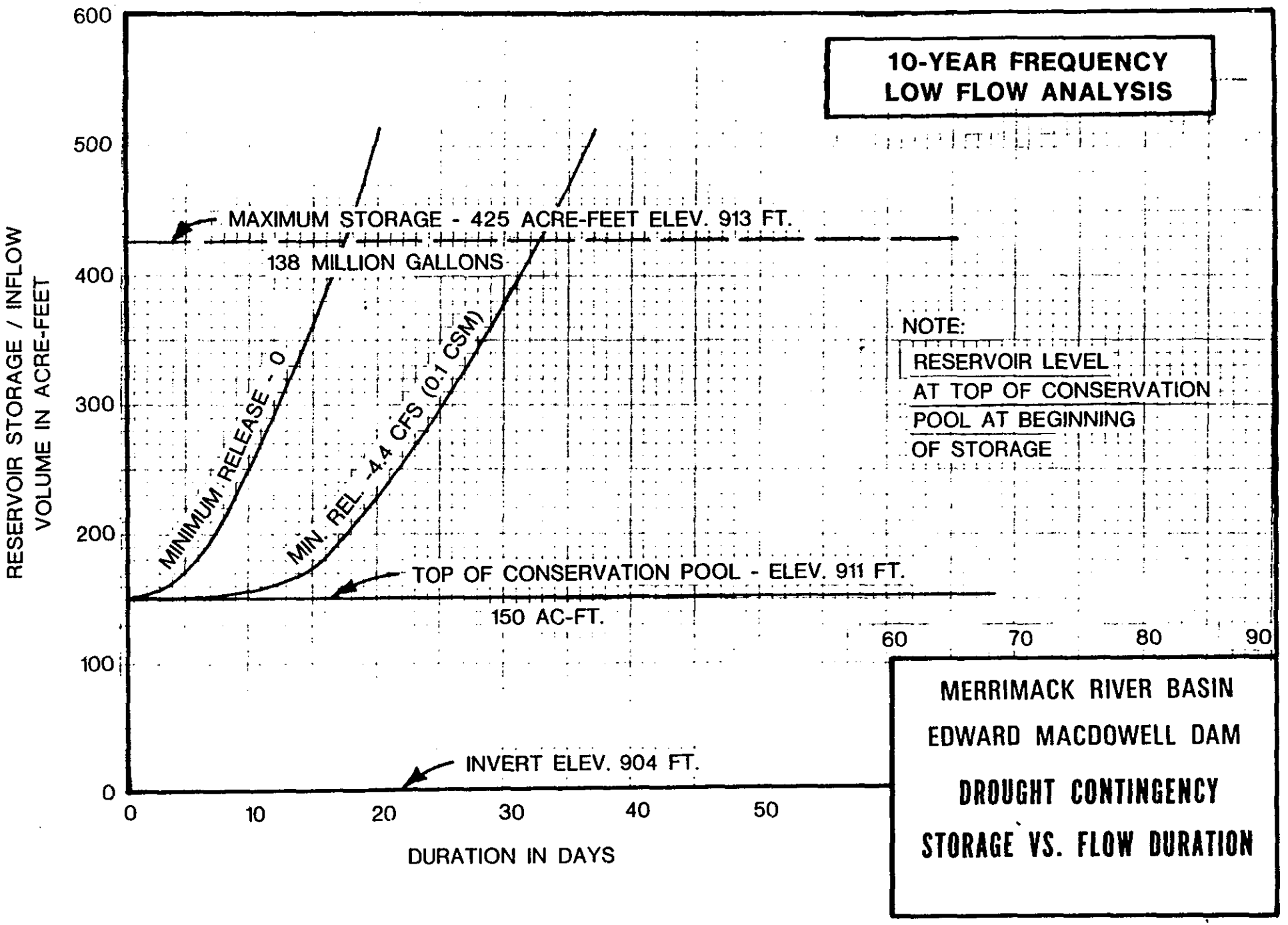
10-YEAR FREQUENCY
LOW FLOW ANALYSIS
RESERVOIR STORAGE / INFLOW
VOLUME IN ACRE-FEET
600
500
400
300
200
100
0
MAXIMUM STORAGE - 425 ACRE-FEET ELEV. 913 FT.
138 MILLION GALLONS
MINIMUM RELEASE - 0
MIN. REL. -4.4 CFS (0.1 CSM)
TOP OF CONSERVATION POOL - ELEV. 911 FT.
150 AC-FT.
INVERT ELEV. 904 FT.
NOTE:
RESERVOIR LEVEL
AT TOP OF CONSERVATION
POOL AT BEGINNING
OF STORAGE
0
10
20
30
40
50
60
70
80
90
DURATION IN DAYS
MERRIMACK RIVER BASIN
EDWARD MACDOWELL DAM
DROUGHT CONTINGENCY
STORAGE VS. FLOW DURATION

PLATE 4

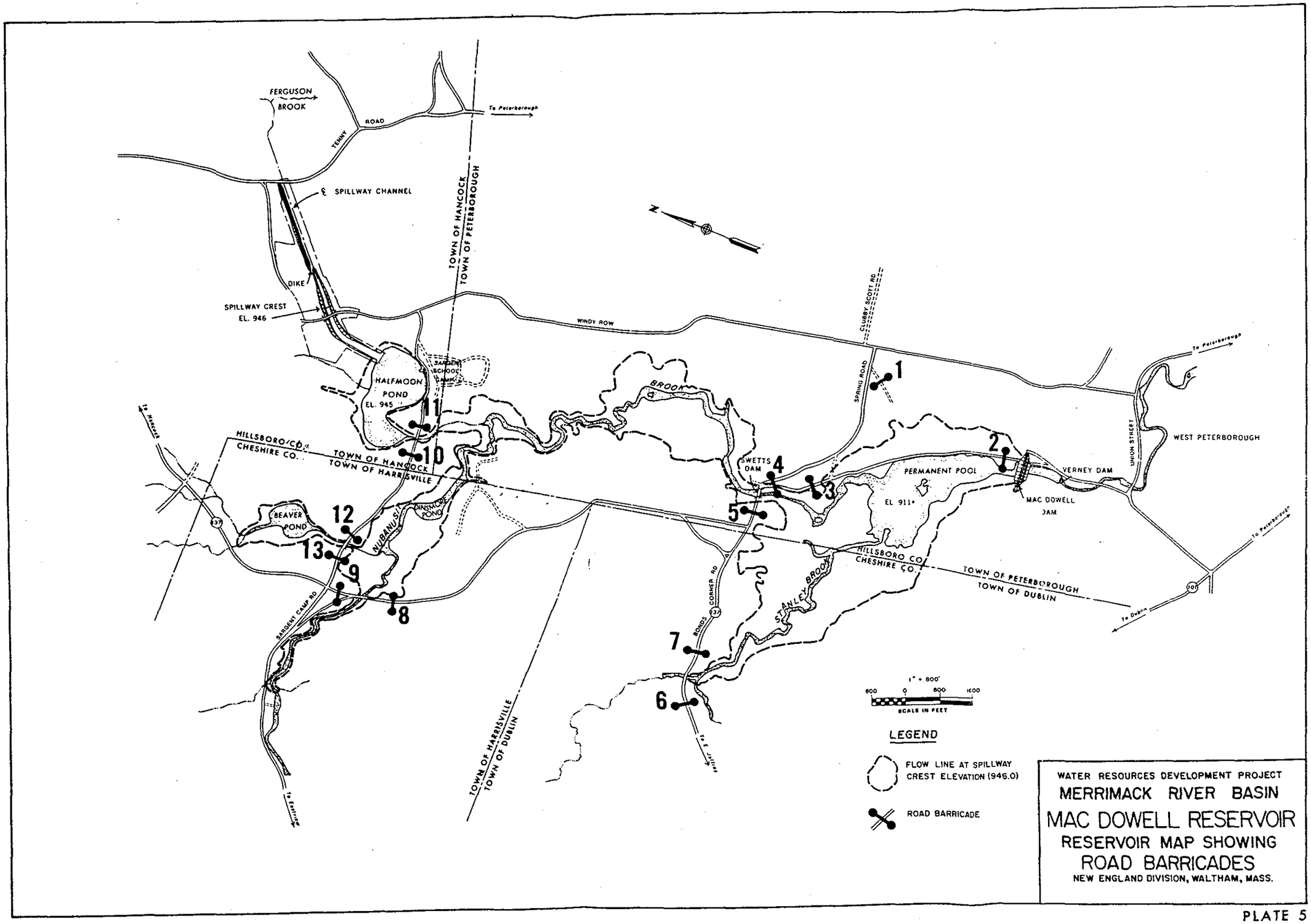
FERGUSON BROOK
TENNY ROAD
To Peterborough
℄ SPILLWAY CHANNEL
DIKE
SPILLWAY CREST EL. 946
TOWN OF HANCOCK
TOWN OF PETERBOROUGH
WINDY ROW
CLUBBY SCOTT RD.
SPRING ROAD
SARGENT SCHOOL CAMP
HALFMOON POND EL. 945
BROOK
To Peterborough
WEST PETERBOROUGH
UNION STREET
To Hancock
HILLSBORO CO.
CHESHIRE CO.
TOWN OF HANCOCK
TOWN OF HARRISVILLE
SWETTS DAM
PERMANENT POOL
EL 911*
VERNEY DAM
MAC DOWELL DAM
BEAVER POND
DINSMORE POND
WUBANUSIT
SARGENT CAMP RD
BONDS CORNER RD
STANLEY BROOK
HILLSBORO CO.
CHESHIRE CO.
TOWN OF PETERBOROUGH
TOWN OF DUBLIN
To Peterborough
To Dublin
TOWN OF HARRISVILLE
TOWN OF DUBLIN
To Eastview
To E. Jaffrey
1" = 800'
800 0 800 1600
SCALE IN FEET
LEGEND
FLOW LINE AT SPILLWAY CREST ELEVATION (946.0)
ROAD BARRICADE
WATER RESOURCES DEVELOPMENT PROJECT
MERRIMACK RIVER BASIN
MAC DOWELL RESERVOIR
RESERVOIR MAP SHOWING
ROAD BARRICADES
NEW ENGLAND DIVISION, WALTHAM, MASS.

PLATE 5